Personal Exposure Monitoring Meets Risk Assessment:

The South Baltimore Community Exposure Study

U.S. EPA Regional/ORD

Workshop on Air Toxics Exposure Assessment

San Francisco

June 27, 2002

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U.S. EPA

Outline

- Background, Objectives, Methods
- Results
  - Air Monitoring
    - Distributions: Indoor, Outdoor, Personal
    - Comparison of S. Baltimore with ASPEN model
  - Risk Estimates
- Policy Implications


Brooklyn Park
Curtis Bay
Brooklyn

Problem Statement

- Assessment of health impacts to HAPs is limited by the uncertainty in exposure estimates based on fix-site ambient monitoring or models that use ambient concentrations to estimate exposure.

2 Questions

- Do results from ambient air modeling provide adequate estimate of actual ambient HAP concentrations, for VOCs?

- Are modeled or actual ambient air quality measures adequate estimators of personal exposure for use in risk characterization and thus adequate providers of the best understanding of where our environmental health policies need to be directed to reduce exposures and health risks?

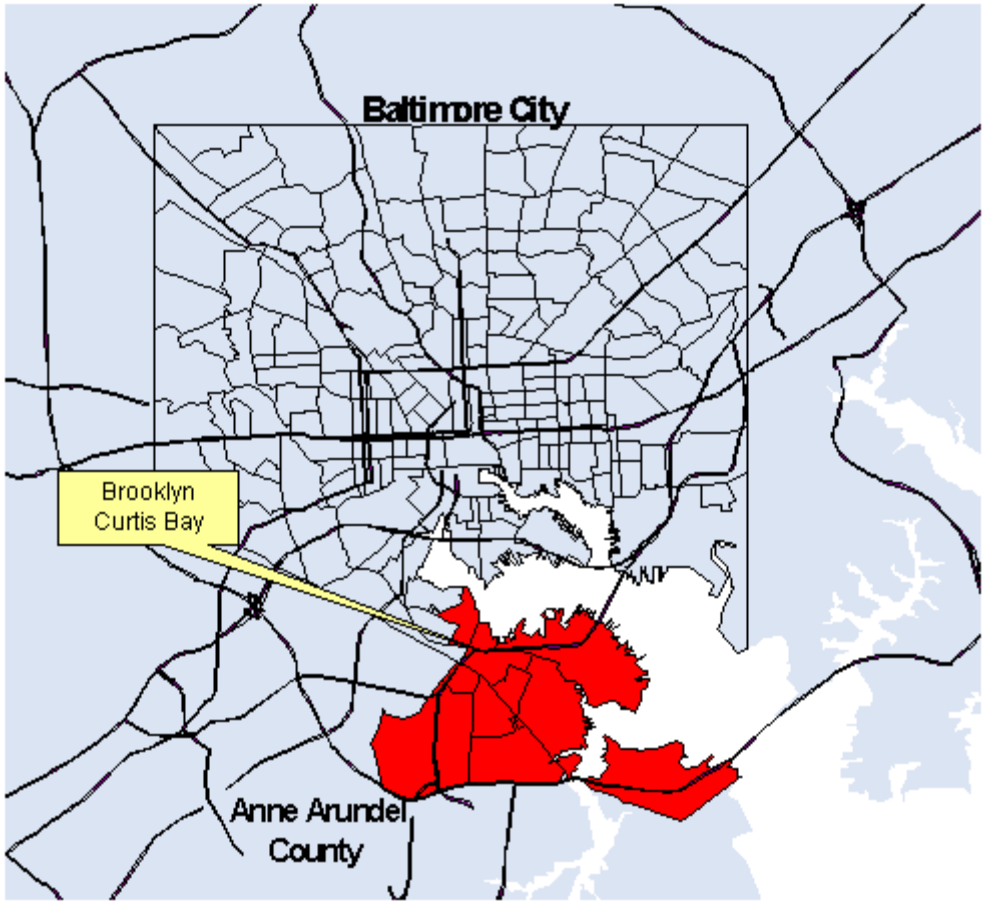
Study Objectives

1. Characterize potential ambient exposures to 12 VOCs according to EPA's ASPEN 1996 model results
2. Measure and characterize actual human exposures to 12 VOCs in South Baltimore
3. Compare ASPEN model results with indoor, outdoor and personal exposure monitoring results
4. Characterize potential public health risks

Methods

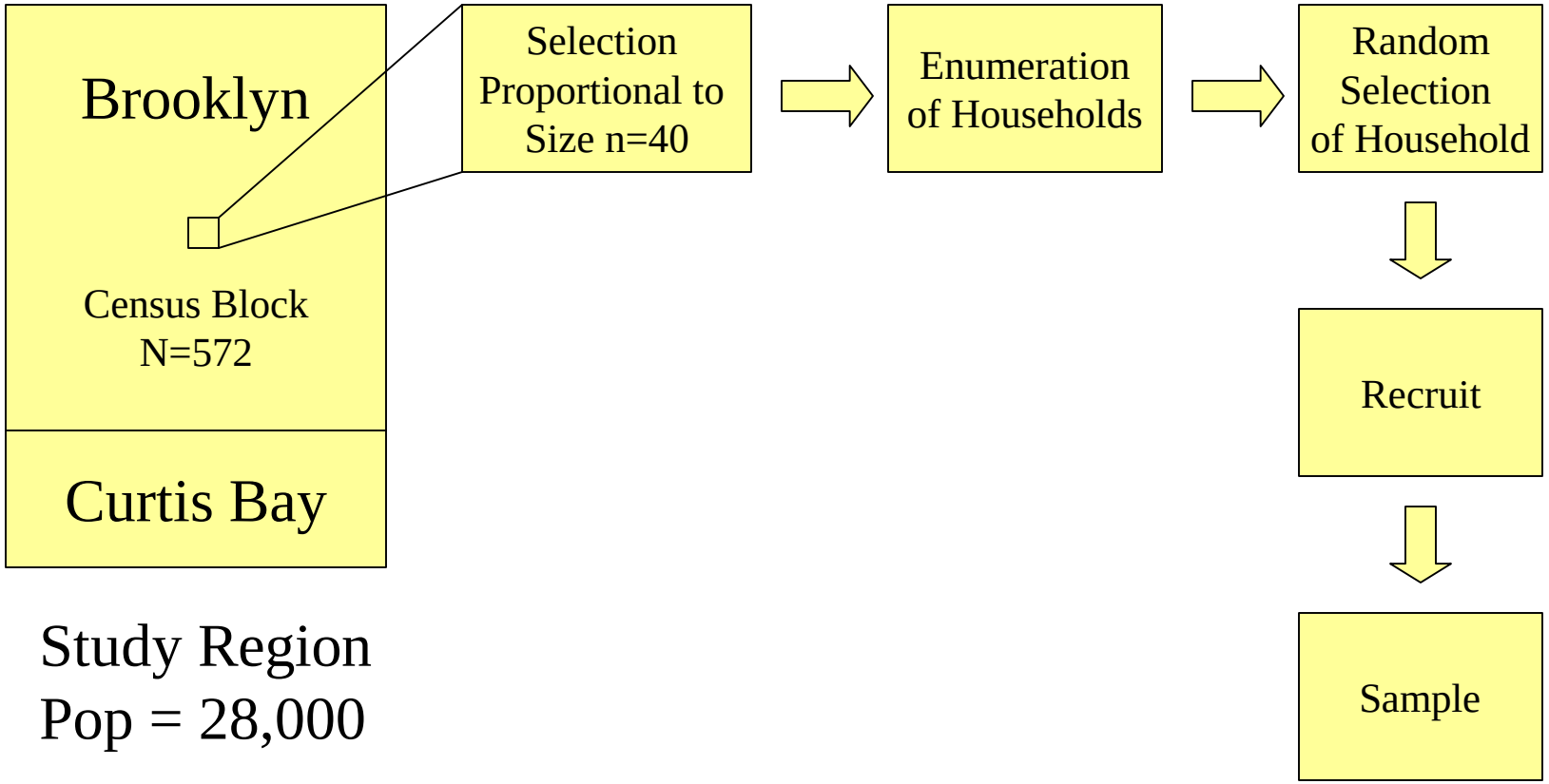
- A random sample of 37 non-smoking adult residents were recruited into the study, but lost 1, n=36; 10 repeats
- Passive air samplers manufactured by 3M (OVM #3500 badges) were used
- 72-hour time-weighted personal exposure, indoor and outdoor VOC concentrations in units of ?g/m^3
- 12 VOCs (all hazardous air pollutants)
- Gas chromatography/mass spectrometry analysis
- 3 questionnaires – baseline, technician walkthrough, time-activity
- Abstracted Maryland data from 1996 ASPEN results
- Estimated cumulative cancer risk based on EPA's CEP approach

The South Baltimore Community Environmental Exposure Study



Survey Design Approach

Population-based Representative Sampling



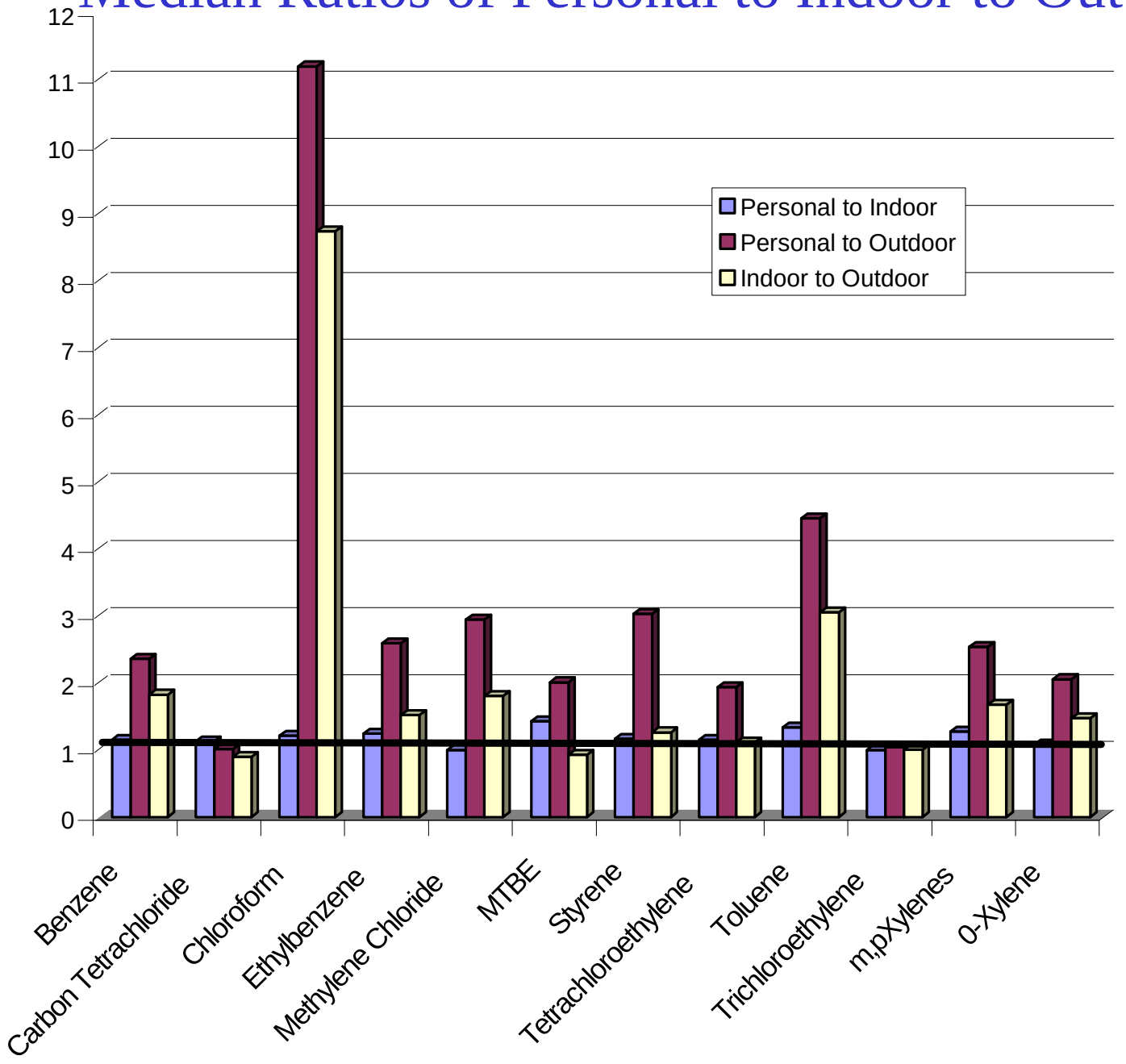
Study Region
Pop = 28,000

Target Analytes

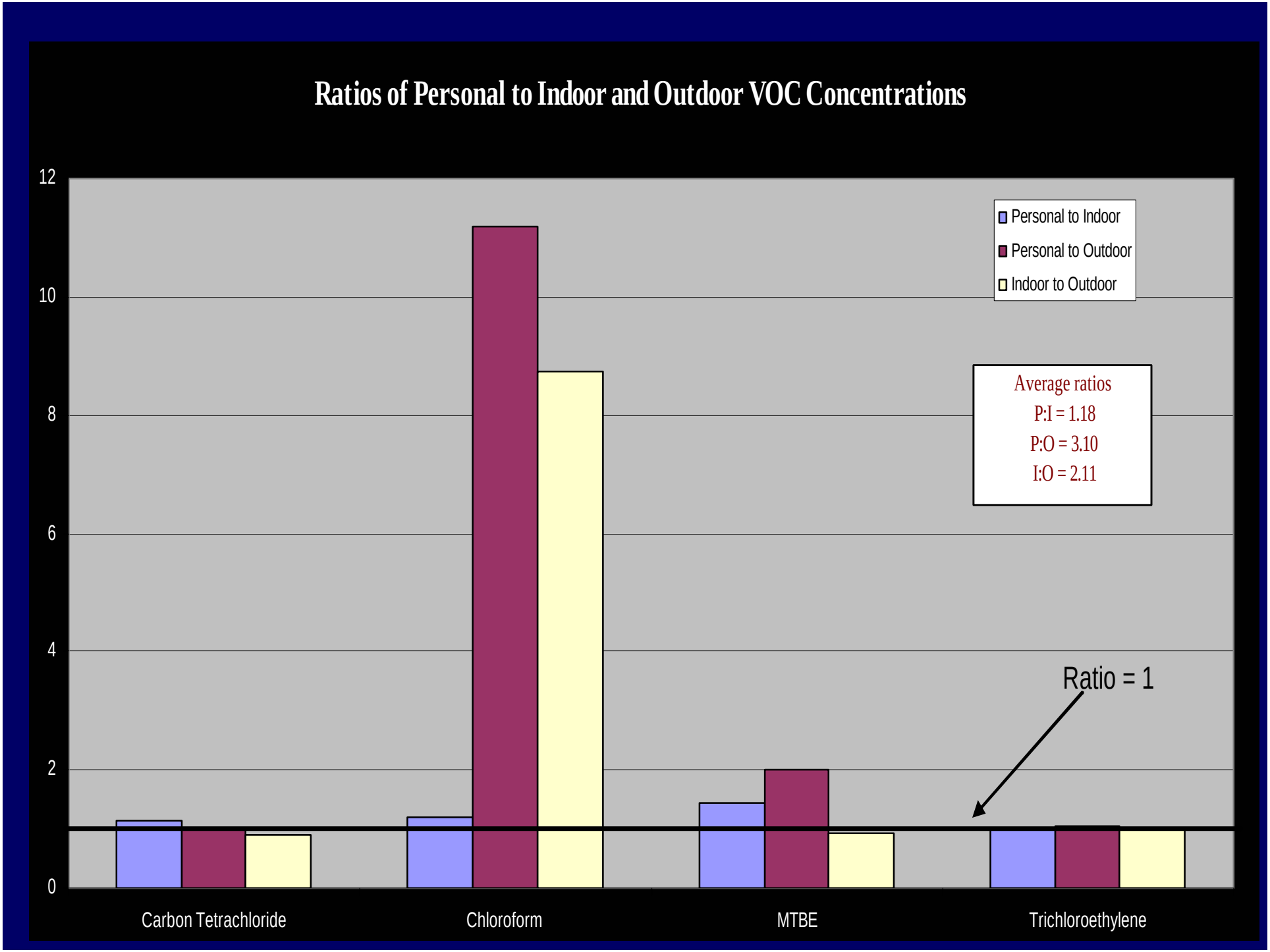
Pollutant	EPA Cancer Classification	Toxicity Values	
		Cancer One per Million Cancer Risk concentration ug/m3	Non-Cancer RfC ug/m3
Benzene	A	0.12	71
Carbon Tetrachloride	B2	0.067	2.4
Chloroform	B2	0.043	35
Ethylbenzene	D	2	1000
Methylene Chloride	B2	2.1	3000
MTBE	D	2	3000
Tetrachloroethylene (perc)	B/C	1.9	35
Toluene	D		400
Trichloroethylene (TCE)	B/C	0.59	640
Styrene	C	2	2
Xylenes	D		300

Source: EPA Air Toxics Website www.epa.gov/ttn/atw; Caldwell, et al. 1998. " Application of Health Information to Hazardous Air Pollutants Modeled in EPA's Cumulative Exposure Project. Toxicology and Industrial Health. 1998 14(3): 429-454.

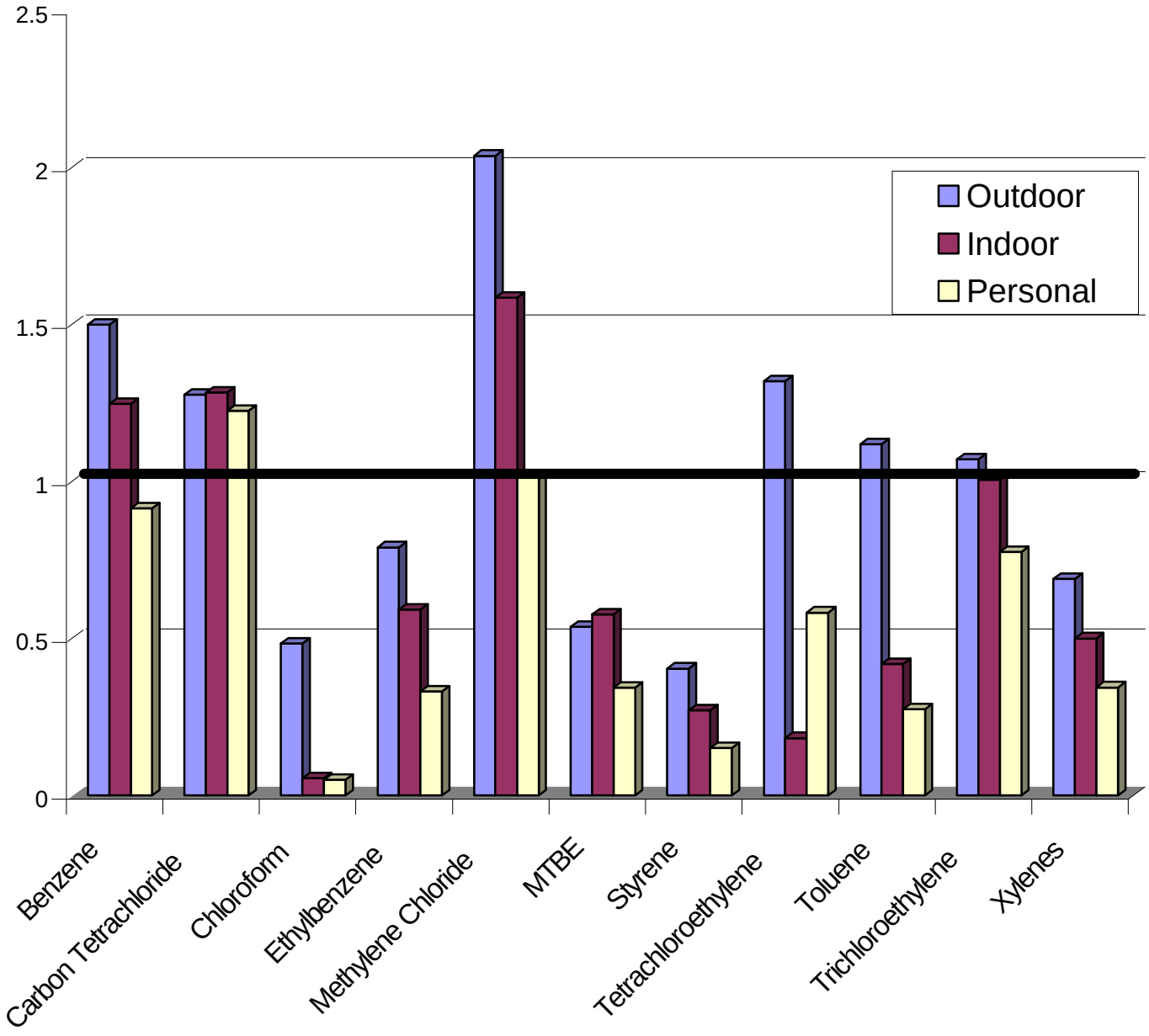
Median Ratios of Personal to Indoor to Outdoor

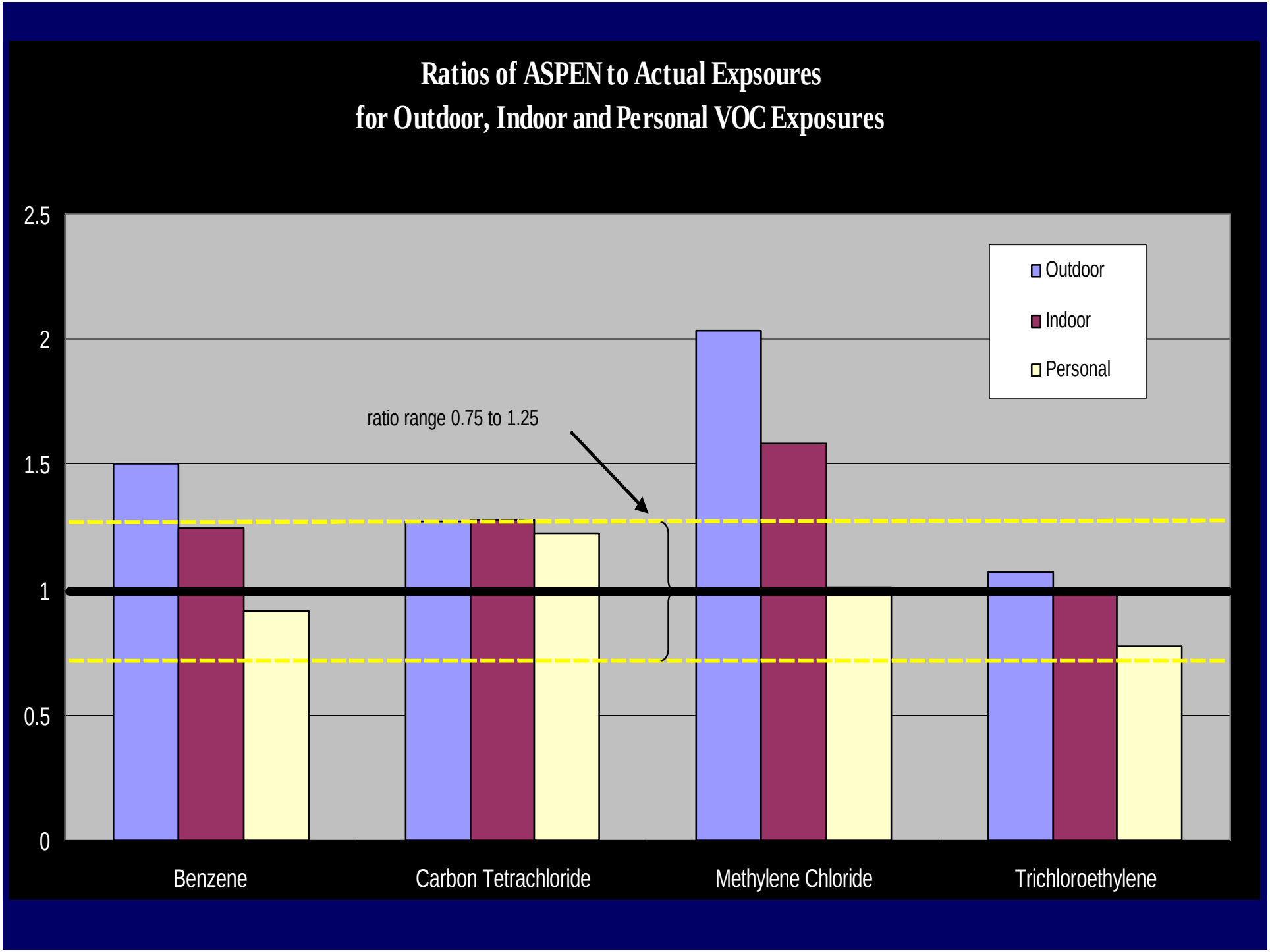


Ave ratios
P:I = 1.18
P:O = 3.10
I:O = 2.11


Ratios of Personal to Indoor and Outdoor VOC Concentrations
12
10
8
6
4
2
0
Personal to Indoor
Personal to Outdoor
Indoor to Outdoor
Average ratios
P:I = 1.18
P:O = 3.10
I:O = 2.11
Ratio = 1
Carbon Tetrachloride
Chloroform
MTBE
Trichloroethylene

Ratios of ASPEN to Actual Exposures

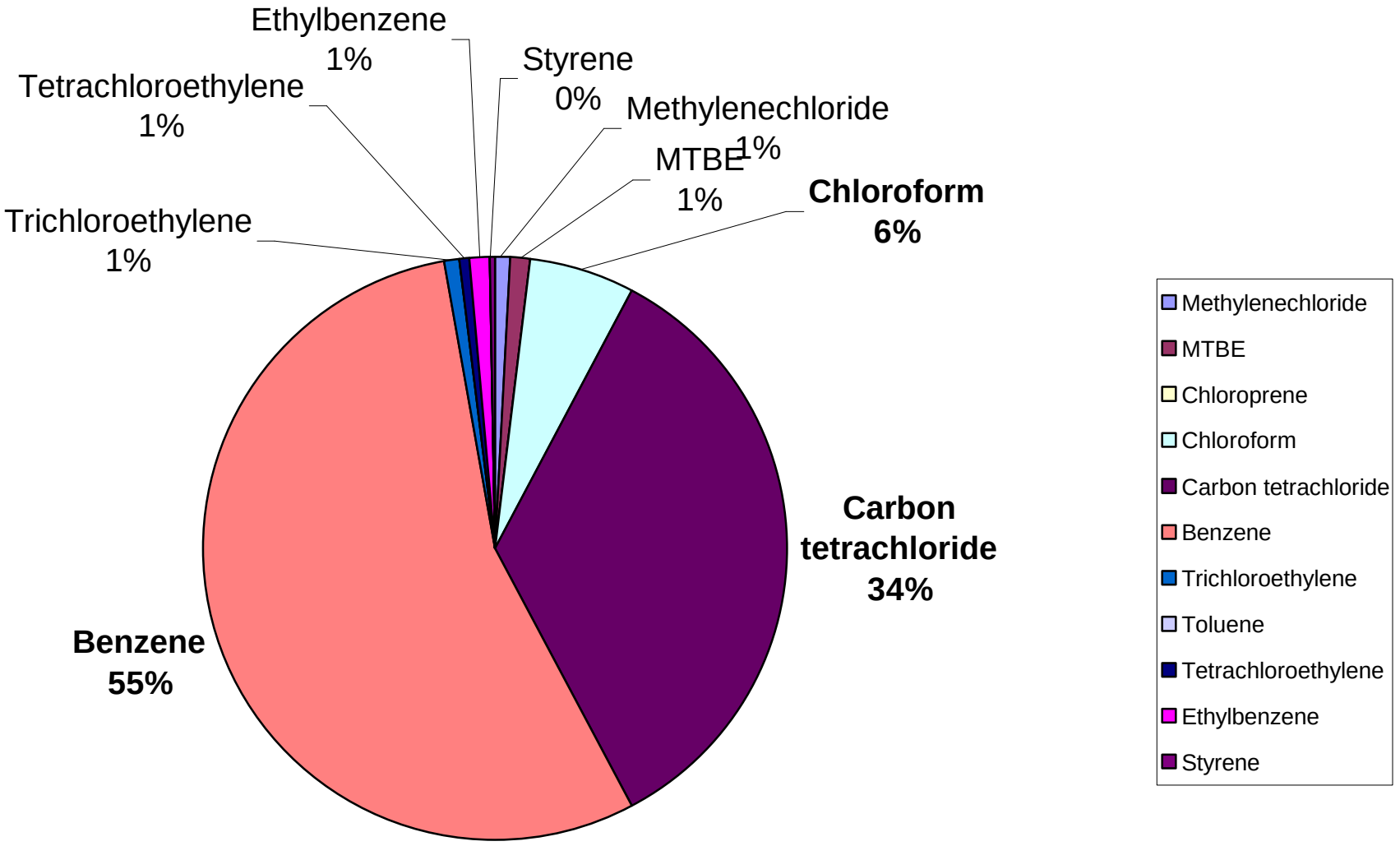



Ratios of ASPEN to Actual Expsoures
for Outdoor, Indoor and Personal VOC Exposures
2.5
2
1.5
1
0.5
0
Outdoor
Indoor
Personal
ratio range 0.75 to 1.25
Benzene
Carbon Tetrachloride
Methylene Chloride
Trichloroethylene

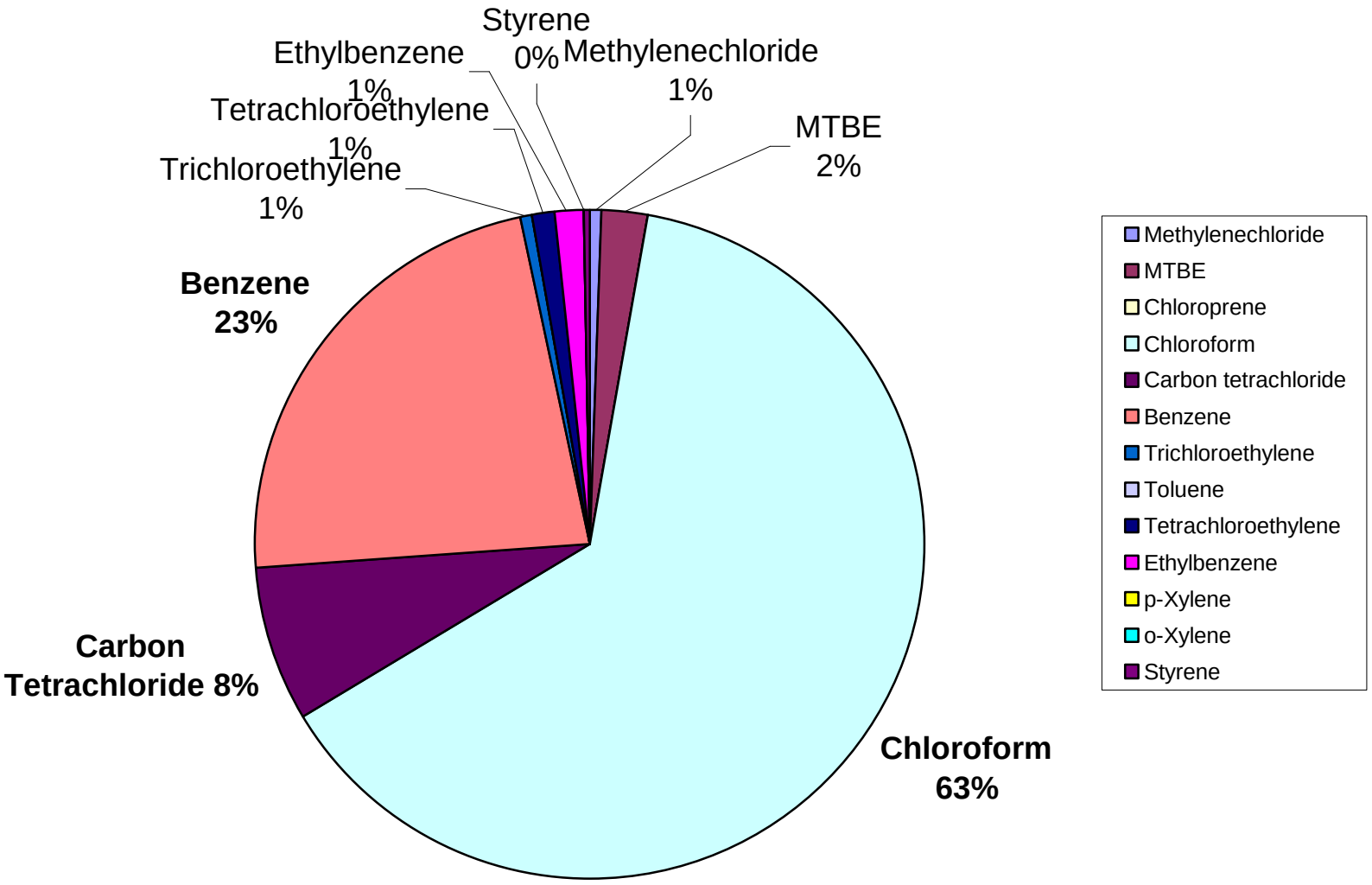
Comparison of Cumulative Cancer Risk by Exposure Category

	Cumulative Risk (risk per 1 million)			Number of Cancer Cases (over a lifetime)		
	Min	**Ave**	Max	Min	**Ave**	Max
Personal Exposure	32	**141**	837	1	**4**	23
Indoor Concentrations	26	**127**	722	1	**4**	20
Outdoor Concentrations	16	**44**	234	0	**1**	7
ASPEN Model	30	**38**	55	1	**1**	2

Proportion of Each VOC to Cumulative Cancer Risk Based on ASPEN Model Concentrations



Proportion of Each VOC to Cumulative Cancer Risk Based on Mean Personal Exposures



Summary of Findings

1. Community Exposures are Consistent with Earlier Studies on Human Exposure to VOCs
2. Modeled Ambient VOC Concentrations are Adequate for Human Exposure for some
3. Modeled Ambient VOC Concentrations Generally Underestimate Human Exposure
4. Underestimation of Exposure Leads to Significant Underestimation of Cumulative Cancer Risk

Limitations

- The study examined exposures to a limited number of air pollutants and therefore any conclusions will be restricted to those compounds
- Short-term exposures assumed representative of long-term exposures

Strengths

- Population-based random sample
- Measured exposure close to the individual
- Cumulative risk analysis

Take Home Messages

- Validate models with actual exposure data
- ASPEN does well for what it was designed to do – ambient VOC concentrations
- ASPEN ok as exposure surrogate for air pollutants with large mobile source and no significant indoor sources

Take Home Messages

- Risk assessment is a tool that exposure scientists should apply to interpret human exposure data
- Risk assessment can help prioritize which pollutants should be targeted for interventions to reduce exposures and health risks
- Focus on ambient VOC exposures will not completely address health risks

Acknowledgements

U.S. EPA Region 3

Mickey Leland Center for Urban Air Toxics

Risk Science and Public Policy Institute

Concerned Citizens for a Better Brooklyn

Community Advisory Committee

Study Participants

% > Method Limit of Detection

Percentage of VOCs with Measurements Greater than Method Limit of Detection

VOC Pollutant	Personal %> LOD	Indoor %> LOD	Outdoor %> LOD
Benzene	100.00%	91.67%	75.00%
Carbon Tetrachloride	100.00%	100.00%	100.00%
Chloroform	100.00%	100.00%	61.11%
Ethylbenzene	97.14%	83.33%	72.22%
Methylene Chloride	71.43%	55.56%	25.00%
MTBE	100.00%	97.22%	97.22%
Styrene	85.71%	63.89%	19.44%
Tetrachloroethylene	80.00%	72.22%	63.89%
Toluene	100.00%	94.44%	69.44%
Trichloroethylene	51.43%	52.78%	25.00%
m,p- Xylenes	100.00%	100.00%	97.22%
o-Xylene	85.71%	86.11%	80.56%

Comparing ASPEN and Exposure Results

- Inter-quartile ranges overlap
- Ratios of Medians
- ASPEN judged good performance if the under/over estimations were no more than 25% of median exposures (ratios of the medians ranging from 0.75 to 1.25)

Comparison of Median ASPEN Model and Exposure Concentrations

For South Baltimore

ug/m3

VOC Pollutant	Exposure Source Category			ASPEN	ASPEN*
	Outdoor	Indoor	Personal	Model	Model
Benzene	1.58	1.90	2.59	2.37	2.38
Carbon Tetrachloride	0.69	0.69	0.72	0.88	0.98
Chloroform	0.20	1.72	1.94	0.09	0.10
Ethylbenzene	1.02	1.36	2.43	0.80	0.80
Methylene Chloride	0.35	0.45	0.70	0.71	0.73
MTBE	3.94	3.67	6.18	2.11	2.24
Styrene	0.25	0.37	0.67	0.10	0.09
Tetrachloroethylene	0.27	1.93	0.60	0.35	0.38
Toluene	4.36	11.66	17.77	4.87	5.12
Trichloroethylene	0.17	0.18	0.23	0.18	0.19
Xylenes	4.79	6.58	9.57	3.29	3.25

Comparison of Ratios and Correlation Coefficients

VOC Pollutant	*Personal to Indoor*		*Personal to Outdoor*		*Indoor to Outdoor*	
	Ratio	r	Ratio	r	Ratio	r
Carbon Tetrachloride	1.12	0.64	1.01	0.59	0.90	0.60
MTBE	1.43	0.6	2.01	0.30	0.93	0.54
TCE	1.00	0.67	1.05	0.33	1.00	0.39